

9-33 CONSTRUCTION GEOSYNTHETIC**9-33.1 Geosynthetic Material Requirements**

The term geosynthetic shall be considered to be inclusive of geotextiles, geogrids, and prefabricated drainage mats.

Geotextiles, including geotextiles attached to prefabricated drainage core to form a prefabricated drainage mat, shall consist only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. The geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation.

Geogrids shall consist of a regular network of integrally connected polymer tensile elements with an aperture geometry sufficient to permit mechanical interlock with the surrounding backfill. The long chain polymers in the geogrid tensile elements, not including coatings, shall consist of at least 95 percent by mass of the material of polyolefins or polyesters. The material shall be free of defects, cuts, and tears.

Prefabricated drainage core shall consist of a three dimensional polymeric material with a structure that permits flow along the core laterally, and which provides support to the geotextiles attached to it.

The geosynthetic shall conform to the properties as indicated in Tables 1 through 8 in Section 9-33.2, and additional tables as required in the Standard Plans and Special Provisions for each use specified in the Plans. Specifically, the geosynthetic uses included in this section and their associated tables of properties are as follows:

Geotextile Geosynthetic Application	Applicable Property Tables
Underground Drainage, Low and Moderate Survivability, Classes A, B, and C	Tables 1 and 2
Separation	Table 3
Soil Stabilization	Table 3
Permanent Erosion Control, Moderate and High Survivability, Classes A, B, and C	Tables 4 and 5
Ditch Lining	Table 4
Temporary Silt Fence	Table 6
Permanent Geosynthetic Retaining Wall	Table 7 and Std. Plans
Temporary Geosynthetic Retaining Wall	Tables 7 and 10
Prefabricated Drainage Mat	Table 8
Table 10 will be included in the Special Provisions.	

Geogrid and geotextile reinforcement in geosynthetic retaining walls shall conform to the properties specified in the Standard Plans for permanent walls, and Table 10 for temporary walls.

For geosynthetic retaining walls that use geogrid reinforcement, the geotextile material placed at the wall face to retain the backfill material as shown in the Plans shall conform to the properties for Construction Geotextile for Underground Drainage, Moderate Survivability, Class A.

Thread used for sewing geotextiles shall consist of high strength polypropylene, polyester, or polyamide. Nylon threads will not be allowed. The thread used to sew permanent erosion control geotextiles, and to sew geotextile seams in exposed faces of temporary or permanent geosynthetic retaining walls, shall also be resistant to ultraviolet radiation. The thread shall be of contrasting color to that of the geotextile itself.

9-33.2 Geosynthetic Properties

9-33.2(1) Geotextile Properties

Table 1: Geotextile for underground drainage strength properties for survivability.

Geotextile Property	ASTM Test Method ²	Geotextile Property Requirements ¹			
		Low Survivability		Moderate Survivability	
		Woven	Nonwoven	Woven	Nonwoven
Grab Tensile Strength, in machine and x-machine direction	D 4632	180 lb min.	115 lb min.	250 lb min.	160 lb min.
Grab Failure Strain, in machine and x-machine direction	D 4632	< 50%	≥ 50%	< 50%	≥ 50%
Seam Breaking Strength	D 4632 ³	160 lb min.	100 lb min.	220 lb min.	140 lb min.
Puncture Resistance	D 6241	370 lb min.	220 lb min.	495 lb min.	310 lb min.
Tear Strength, in machine and x-machine direction	D 4533	67 lb min.	40 lb min.	80 lb min.	50 lb min.
Ultraviolet (UV) Radiation Stability	D 4355	50% strength retained min., after 500 hours in a xenon arc device			

Table 2: Geotextile for underground drainage filtration properties.

Geotextile Property	ASTM Test Method ²	Geotextile Property Requirements ¹		
		Class A	Class B	Class C
AOS	D 4751	U.S. No. 40 max.	U.S. No. 60 max.	U.S. No. 80 max.
Water Permittivity	D 4491	0.5 sec ⁻¹ min.	0.4 sec ⁻¹ min.	0.3 sec ⁻¹ min.

Table 3: Geotextile for separation or soil stabilization.

Geotextile Property	ASTM Test Method ²	Geotextile Property Requirements ¹			
		Separation		Soil Stabilization	
		Woven	Nonwoven	Woven	Nonwoven
AOS	D 4751	U.S. No. 30 max.		U.S. No. 40 max.	
Water Permittivity	D 4491	0.02 sec ⁻¹ min.		0.10 sec ⁻¹ min.	
Grab Tensile Strength, in machine and x-machine direction	D 4632	250 lb min.	160 lb min.	315 lb min.	200 lb min.
Grab Failure Strain, in machine and x-machine direction	D 4632	< 50%	≥ 50%	< 50%	≥ 50%
Seam Breaking Strength	D 4632 ³	220 lb min.	140 lb min.	270 lb min.	180 lb min.
Puncture Resistance	D 6241	495 lb min.	310 lb min.	620 lb min.	430 lb min.
Tear Strength, in machine and x-machine direction	D 4533	80 lb min.	50 lb min.	112 lb min.	79 lb min.
Ultraviolet (UV) Radiation Stability	D 4355	50% strength retained min., after 500 hours in xenon arc device			

Table 4: Geotextile for permanent erosion control and ditch lining.

Geotextile Property	ASTM Test Method ²	Geotextile Property Requirements ¹					
		Permanent Erosion Control				Ditch Lining	
		Moderate Survivability		High Survivability			
		Woven	Nonwoven	Woven	Nonwoven	Woven	Nonwoven
AOS	D 4751	See Table 5		See Table 5		U.S. No. 30 max.	
Water Permittivity	D 4491	See Table 5		See Table 5		0.02 sec ⁻¹ min.	
Grab Tensile Strength, in machine and x-machine direction	D 4632	250 lb min.	160 lb min.	315 lb min.	200 lb min.	250 lb min.	160 lb min.
Grab Failure Strain, in machine and x-machine direction	D 4632	15% -50%	≥ 50%	15% - 50%	≥ 50%	< 50%	≥ 50%
Seam Breaking Strength	D 4632 ³	220 lb min.	140 lb min.	270 lb min.	180 lb min.	220 lb min.	140 lb min.
Puncture Resistance	D 6241	495 lb min.	310 lb min.	620 lb min.	430 lb min.	495 lb min.	310 lb min.
Tear Strength, in machine and x-machine direction	D 4533	80 lb min.	50 lb min.	112 lb min.	79 lb min.	80 lb min.	50 lb min.
Ultraviolet (UV) Radiation Stability	D 4355	70% strength retained min., after 500 hours in xenon arc device					

Table 5: Filtration properties for geotextile for permanent erosion control.

Geotextile Property	ASTM Test Method ²	Geotextile Property Requirements ¹		
		Class A	Class B	Class C
AOS	D 4751	U.S. No. 40 max.	U.S. No. 60 max.	U.S. No. 70 max.
Water Permittivity	D 4491	0.7 sec ⁻¹ min.	0.4 sec ⁻¹ min.	0.2 sec ⁻¹ min.

Table 6: Geotextile for temporary silt fence.

Geotextile Property	ASTM Test Method ²	Geotextile Property Requirements ¹	
		Unsupported Between Posts	Supported Between Posts with Wire or Polymeric Mesh
AOS	D 4751	U.S. No. 30 max. for slit wovens, U.S. No. 50 for all other geotextile types, U.S. No. 100 min.	
Water Permittivity	D 4491	0.02 sec ⁻¹ min.	
Grab Tensile Strength, in machine and x-machine direction	D 4632	180 lb min. in machine direction, 100 lb min. in x-machine direction	100 lb min.
Grab Failure Strain, in machine and x-machine direction	D 4632	30% max. at 180 lb or more	
Ultraviolet (UV) Radiation Stability	D 4355	70% strength retained min., after 500 hours in xenon arc device	

9-33.2(2) Geosynthetic Properties For Retaining Walls and Reinforced Slopes

Table 7: Minimum properties required for geotextile reinforcement used in geosynthetic reinforced slopes and retaining walls.

Geotextile Property	ASTM Test Method ²	Geotextile Property Requirements ¹	
		Woven	Nonwoven
AOS	D 4751	U.S. No. 20 max.	
Water Permittivity	D 4491	0.02 sec ⁻¹ min.	
Grab Tensile Strength, in machine and x-machine direction	D 4632	200 lb min.	120 lb min.
Grab Failure Strain, in machine and x-machine direction	D 4632	< 50%	≥ 50%
Seam Breaking Strength	D 4632 ^{3,4}	160 lb min.	100 lb min.
Puncture Resistance	D 6241	370 lb min.	220 lb min.
Tear Strength, in machine and x-machine direction	D 4533	63 lb min.	50 lb min.
Ultraviolet (UV) Radiation Stability	D 4355	70% (for polypropylene and polyethylene) and 50% (for polyester) Strength Retained min., after 500 hours in a xenon arc device	

9-33.2(3) Prefabricated Drainage Mat

Prefabricated drainage mat shall have a single or double dimpled polymeric core with a geotextile attached and shall meet the following requirements:

Table 8: Minimum properties required for prefabricated drainage mats.

Geotextile Property	ASTM Test Method²	Geotextile Property Requirements¹
AOS	D 4751	U.S. No. 60 max.
Water Permittivity	D 4491	0.4 sec ⁻¹ min.
Grab Tensile Strength, in machine and x-machine direction	D 4632	Nonwoven – 100 lb min.
Width Thickness	D 5199	12 In. min. 0.4 In. min.
Compressive Strength at Yield	D 1621	100 psi min.
In Plan Flow Rate Gradient = 0.1, Pressure = 5.5 psi Gradient = 1.0, Pressure = 14.5 psi	D 4716	5.0 gal./min./ft. 15.0 gal./min./ft.

¹ All geotextile properties in Tables 1 through 8 are minimum average roll values (i.e., the test results for any sampled roll in a lot shall meet or exceed the values shown in the table).

² The test procedures used are essentially in conformance with the most recently approved ASTM geotextile test procedures, except for geotextile sampling and specimen conditioning, which are in accordance with WSDOT Test Methods T 914, Practice for Sampling of Geotextiles for Testing, and T 915, Practice for Conditioning of Geotextiles for Testing, respectively. Copies of these test methods are available at the State Materials Laboratory P.O. Box 47365, Olympia, WA 98504-7365.

³ With seam located in the center of 8-inch long specimen oriented parallel to grip faces.

⁴ Applies only to seams perpendicular to the wall face.

9-33.3 Aggregate Cushion of Permanent Erosion Control Geotextile

Aggregate cushion for permanent erosion control geotextile, Class A shall meet the requirements of Section 9-03.9(2). Aggregate cushion for permanent erosion control geotextile, Class B or C shall meet the requirements of Section 9-03.9(3) and 9-03.9(2).

9-33.4 Geosynthetic Material Approval and Acceptance

9-33.4(1) Geosynthetic Material Approval

If the geosynthetic source material has not been previously evaluated, or is not listed in the current WSDOT Qualified Products List (QPL), a sample of each proposed geosynthetic shall be submitted to the State Materials Laboratory in Tumwater for evaluation. Geosynthetic material approval will be based on conformance to the applicable properties from the Tables in Section 9-33.2 or in the Standard Plans or Special Provisions. After the sample and required information for each geosynthetic type have arrived at the State Materials Laboratory in Tumwater, a maximum of 14 calendar days will be required for this testing. Source approval shall not be the basis of acceptance of specific lots of material delivered to the Contractor unless the roll numbers of the lot sampled can be clearly identified as the rolls tested and approved in the geosynthetic approval process.

For geogrid and geotextile products proposed for use in permanent geosynthetic retaining walls or reinforced slopes that are not listed in the current QPL, the Contractor shall submit test information and the calculations used in the determination of T_{al} performed in accordance with WSDOT Standard Practice T 925, Standard Practice for Determination of Long-Term Strength for Geosynthetic Reinforcement, to the State Materials Laboratory in Tumwater for evaluation. The Contracting Agency will require up to 30 calendar days after 1 receipt of the information to complete the evaluation.

The Contractor shall submit to the Engineer the following information regarding each geosynthetic material proposed for use:

- Manufacturer's name and current address,
- Full product name,
- Geosynthetic structure, including fiber/yarn type,
- Geosynthetic polymer type(s) (for temporary and permanent geosynthetic retaining walls),
- Proposed geosynthetic use(s), and
- Certified test results for minimum average roll values.

9-33.4(2) Vacant

9-33.4(3) Acceptance Samples

When the quantities of geosynthetic materials proposed for use in the following geosynthetic applications are greater than the following amounts, acceptance shall be by satisfactory test report:

Application	Geosynthetic Quantity
Underground Drainage	600 sq. yd.
Temporary or Permanent Geosynthetic Retaining Walls	All quantities

The samples for acceptance testing shall include the information about each geosynthetic roll to be used as stated in 9-33.4(4).

Samples will be randomly taken by the Engineer at the job site to confirm that the geosynthetic meets the property values specified.

Approval will be based on testing of samples from each lot. A "lot" shall be defined for the purposes of this Specification as all geosynthetic rolls within the consignment (i.e., all rolls sent to the project site) that were produced by the same manufacturer during a continuous period of production at the same manufacturing plant and have the same product name. After the samples have arrived at the State Materials Laboratory in Tumwater, a maximum of 14 calendar days will be required for this testing.

If the results of the testing show that a geosynthetic lot, as defined, does not meet the properties required for the specified use as indicated in Tables 1 through 8 in Section 9-33.2, and additional tables as specified in the Special Provisions, the roll or rolls which were sampled will be rejected. Geogrids and geotextiles for temporary geosynthetic retaining walls shall meet the requirements of Table 7, and Table 10 in the Special Provisions. Geogrids and geotextiles for permanent geosynthetic retaining wall shall meet the requirements of Table 7, and Table 9 in the Special Provisions, and both geotextile and geogrid acceptance testing shall meet the required ultimate tensile strength T_{ult} as provided in the current QPL for the selected product(s). If the selected product(s) are not listed in the current QPL, the result of the testing for T_{ult} shall be greater than or equal to

T_{ult} as determined from the product data submitted and approved by the State Materials Laboratory during source material approval.

Two additional rolls for each roll tested which failed from the lot previously tested will then be selected at random by the Engineer for sampling and retesting. If the retesting shows that any of the additional rolls tested do not meet the required properties, the entire lot will be rejected. If the test results from all the rolls retested meet the required properties, the entire lot minus the roll(s) that failed will be accepted. All geosynthetic that has defects, deterioration, or damage, as determined by the Engineer, will also be rejected. All rejected geosynthetic shall be replaced at no additional expense to the Contracting Agency.

9-33.4(4) Acceptance by Certificate of Compliance

When the quantities of geosynthetic proposed for use in each geosynthetic application are less than or equal to the following amounts, acceptance shall be by Manufacturer's Certificate of Compliance:

Application	Geosynthetic Quantity
Underground Drainage	600 sq. yd.
Soil Stabilization and Separation	All quantities
Permanent Erosion Control	All quantities
Temporary Silt Fence	All quantities
Prefabricated Drainage Mat	All quantities

The Manufacturer's Certificate of Compliance shall include the following information about each geosynthetic roll to be used:

- Manufacturer's name and current address,
- Full product name,
- Geosynthetic structure, including fiber/yarn type,
- Geosynthetic Polymer type (for all temporary and permanent geosynthetic retaining walls only),
- Geosynthetic roll number(s),
- Geosynthetic lot number(s),
- Proposed geosynthetic use(s), and
- Certified test results.

9-33.4(5) Approval of Seams

If the geotextile seams are to be sewn in the field, the Contractor shall provide a section of sewn seam that can be sampled by the Engineer before the geotextile is installed. The seam sewn for sampling shall be sewn using the same equipment and procedures as will be used to sew the production seams. If production seams will be sewn in both the machine and cross-machine directions, the Contractor must provide sewn seams for sampling which are oriented in both the machine and cross-machine directions.

The seam sewn for sampling must be at least 2 yards in length in each geotextile direction. If the seams are sewn in the factory, the Engineer will obtain samples of the factory seam at random from any of the rolls to be used. The seam assembly description shall be submitted by the Contractor to the Engineer and will be included with the seam sample obtained for testing. This description shall include the seam type, stitch type, sewing thread type(s), and stitch density.